West Basin Facility Plan Project 7054

TECHNICAL MEMORANDUM 7

Rock Creek WRRF Odor Control Evaluation

FINAL / June 2025

Produced by: carollo

Clean Water Services

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Abbreviations

CAMP®	concentrated, accelerated, motivated, problem-solving
cfm	cubic feet per minute
District	Clean Water Services
FRP	fiberglass reinforced plastic
ft^3	cubic feet
gpm	gallons per minute
H_2S	hydrogen sulfide
hp	horsepower
IPS	influent pump station
O&M	operations and maintenance
ppm	parts per million
VFD	variable frequency drive
WRRF	Water Resource Recovery Facility

TM 7 ROCK CREEK WRRF ODOR CONTROL EVALUATION

7.1 Introduction

Reliable odor treatment is important for the Rock Creek Water Resource Recovery Facility (WRRF) since it is in a residential area with neighbors close to the fence line. As part of the West Basin Facility Plan project, Clean Water Services (the District) requested an evaluation of the existing odor control systems for two process areas: the influent pump station (IPS) and the headworks. The headworks odor control system serves several separate processes including the bar screens, grit removal, and primary clarifiers among others. The objectives of this study are to:

- Evaluate the condition and capacity of the existing odor control systems.
- Determine the need for and benefit of potential improvements or upgrades.
- Determine capital and operations and maintenance (O&M) costs, resulting in a selection of odor treatment technologies.

7.2 Background

7.2.1 Influent Pump Station

Odorous air is pulled from the IPS wet wells and inlet box by fans that convey the air to a Calgon Carbon Phoenix system shown in Figure 7.1. A negative pressure is maintained on the headspace to prevent nuisance odors from escaping. Fresh air inlets with backdraft dampers are included on the top of the structures to maintain proper airflow while preventing odor leakage if the system is temporarily offline.

The condition and effective capacity of the IPS odor control system was discussed with District O&M staff via teleconference. In general, the system performs well with an approximate treatment capacity of 8,000 cubic feet per minute (cfm) despite a service life greater than 20 years. Performance is monitored by an hydrogen sulfide (H_2S) sensor on the discharge of the unit, which is used to monitor when breakthrough begins to occur. Odor breakthroughs, with H_2S concentrations of 5 to 30 parts per million (ppm), are observed once every 9 to 12 months. These occurrences indicate the media is spent and must be replaced. Automated backwashing occurs between media replacements to recharge the carbon and extend useful life. The current cost of media replacement is approximately $20,000 for all cannisters.

Two 14,000 cfm fans operated on variable frequency drives (VFD) provide redundant capacity for the odorous air treatment system. The fans are currently in a duty-standby configuration with their speed trimmed to maintain constant suction pressure and a flow rate of approximately 8,000 cfm. The odorous air fans were recently upgraded and are currently in good condition. There are no plans for modification or expansion of the fans during the planning period of this study.

Figure 7.1 Existing IPS Odor Control System

7.2.2 Headworks and Primary Clarification

The Rock Creek Headworks and Primary Clarification odor control system has two chemical packed tower scrubbers (scrubbers)that pull air from the headworks and primary clarifiers. Each scrubber is equipped with a variable speed fan. The variable speed fan pulls air out of the confined spaces and delivers it to the scrubbers (Figure 7.2); the scrubbers use sodium hydroxide and sodium hypochlorite to treat odorous compounds in the foul air.

Each scrubber is sized for 25,000 cfm. One fan and scrubber fan pull from the primary clarifiers at a flow rate of around 11,000 cfm. The other fan and scrubber pull air from the headworks channels, bar screens, washer compactors, grit removal, and screening haul-off bins. The condition and effective capacity of the headworks and primary clarification odor control system was discussed with District O&M staff via teleconference. The system performs well and the packing media only needs to be changed once every 15 years. District O&M staff said that the existing fans are near the end of their useful life and should be replaced. It was also noted that with the addition of Primary Clarifier 4 some of the ducting runs are undersized and need to be addressed. The chemical scrubbers are not equipped with an H_2S sensor and so there are no readings for the system.

District staff did not report issues with the ability to reliably supply chemicals for odor control; however, the addition of a redundant foul air fan was suggested as a way to improve the reliability of the odor control systems.

Figure 7.2 Existing Headworks and Primary Clarification Odor Control System

7.3 Odor Control Alternatives

7.3.1 Influent Pump Station

A previous study (Brown and Caldwell 2014) summarizing prior H_2S samples from the IPS wet well taken in June 2010 indicated that the average H_2S concentrations from this space are fairly low; approximately 0.1 ppm with occasional spikes of 1-5 ppm and even rarer spikes of approximately 18 ppm. These low H_2S concentrations are typically suitable for carbon scrubbers and are not considered suitably high enough to sustain a robust thiobacillus bacteria population necessary for a separate, dedicated biological odor control system. Based on prior samples in the 2014 study, the most feasible odor technology for the IPS is the carbon system.

7.3.2 Headworks and Primary Clarification

As indicated previously, the current odor control systems use chemical packed scrubbers to treat odors from the headworks and primary clarifiers. Chemical scrubbers can remove up to 99 percent of hydrogen sulfide, even at high concentrations. They require a relatively small footprint, but require chemical handling and storage, and disposal of scrubber effluent wastewater.

Biological odor treatment systems can also remove up to 99 percent of hydrogen sulfide at high concentrations. Typically, headworks and primary clarifier areas show H_2S levels that range between 5 to 30 ppm – a suitable range for biological treatment.

These two technologies were compared using design criteria summarized in Table 7.1.

Table 7.1 Design Criteria comparison – Chemical scrubber and Biological Scrubber

Description	Unit	Existing Chemical Scrubber	Biological Scrubber
Number of Units	--	2	4
Rated Air Capacity (each unit)	cfm	25,000	12,500
Inlet H_2S	ppm	5-30	5-30
H_2S Removal Efficiency		99% or less than 0.5 ppm whichever is greater	99% or less than 0.5 ppm whichever is greater
Make-Up Water/ Blow Down Flow Rate per scrubber	gpm	10	5
Recirculation Pump			
Flow Rate per scrubber	gpm	500	75
Motor Load per scrubber	hp	40	7.5
Total Motor Load	hp	80	30
Fans			
Type		Centrifugal	Centrifugal
Materials		FRP	FRP
Air Flow per scrubber	cfm	25,000	12,500
Total Motor Load	hp	100	100
Drive		VFD	VFD

Notes:
FRP - fiberglass reinforced plastic; gpm - gallons per minute; hp - horsepower.

7.4 Odor Control Alternative Cost Comparison

As previously noted, carbon is the most viable odor control technology for the IPS, and continued use of carbon is recommended to treat foul air from this source. The analysis presented in Section 7.4.1 illustrates that carbon is the most cost-effective option over a range of H_2S concentrations. A life-cycle cost analysis for the headworks and primary clarifier odor control source is presented below. Capital costs, O&M costs, and life cycle cost analysis were developed using a combination of vendor quotes and recent project experience. Allowances for ductwork, electrical work, instrumentation and controls, and demolition were also included. The costs presented are a budget level estimate that are representative of a

Class 5 cost estimate as described in AACE International[1] guidelines. All costs are based on 2024 pricing of materials, equipment, labor, and other components listed.

These preliminary estimates include direct and indirect costs. Direct costs include materials, labor, construction equipment required for installation, and subcontractor costs and are estimated based on quotes from equipment vendors, experience on similar projects, and estimated quantities and unit prices. Indirect costs include an estimating contingency, sales tax, and contractor general conditions and overhead and profit and risk consistent with assumptions outlined in the CAMP® documentation:

- Contingency (30 percent).
- General Conditions (10 percent).
- General Contractor Overhead and Profit (12 percent).
- Engineering, Management and Legal (20 percent).

Annual O&M cost estimates include the following assumptions:

- Energy cost is based on an average power cost of $0.06/ kilowatt-hour 365 days a year continuous operation.
- Bioscrubber Media replacement cost is based on 10-year replacement of media volume per vessel at $35 per cubic foot ($ft^3$) replacement cost.
- Chemical packing Scrubber Media replacement cost is based on 10-year replacement of media volume per vessel at $35/$ft^3$ replacement cost.
- Phoenix carbon canister replacement is based on 40 carbon canisters at $1000/canister according to the manufacturer.
- Water consumption cost is based on $0.003/gallon.
- The chemical cost is based on data received from CWS.
- Maintenance and Labor cost is based on two maintenance hours/week at $69.61/hr.
- O&M present worth cost is based on 20-year operating period in 2024 dollars.

7.4.1 Influent Pump Station Odor Control Cost Analysis

The cost analysis for the IPS odor control alternatives presents four scenarios with inlet H_2S concentrations between less than 5 ppm and up to 30 ppm. For scenario 1, biological odor technology is not feasible since the microbes cannot thrive below inlet H_2S concentrations of 5 ppm. In this case only the Calgon Carbon Phoenix system has been analyzed (Table 7.2). For the other scenarios with higher inlet H_2S concentrations, both the Phoenix system and the biological odor technology are viable. Tables 7.3 through 7.5 compare costs of the two technologies for inlet H_2S concentrations of 10 ppm, 20 ppm, and 30 ppm. As shown, in each case continued use of carbon is the most cost-effective option.

[1] AACE 18R-97. *Cost Estimate Classification System – As applied in Engineering, Procurement, and Construction for the Process Industries.*

Table 7.2 20-Year Life Cycle Cost Analysis Influent Pump Station Odor Control Scenario 1 - Inlet H_2S 5 ppm

Item	Phoenix Scrubber
Total Project Cost	**N/A**
Annual O&M Costs	
Energy	$9,800
Cannisters Media Replacement	$20,000
Water	$4,500
Maintenance and Labor	$7,200
Total O&M Cost	**$41,500**
20-Year Life Cycle Cost	
20-Year Operating Cost	$830,000
Total Project Cost	N/A
Total 20-Year Present Worth	**$830,000**

Table 7.3 20-Year Life Cycle Cost Analysis Influent Pump Station Odor Control Scenario 2 - Inlet H_2S 10 ppm

Item	Phoenix Scrubber	Biological Scrubber
Project Capital Costs		
New Biological Scrubber	-	$780,000
Installation cost (50% of equipment cost)	-	$390,000
Total Direct Cost	**-**	**$1,170,000**
Total Project Cost	**-**	**$2,249,000**
Annual O&M Costs		
Energy	$9,800	$4,000
Media Replacement	$40,000	$7,000
Water	$4,500	$4,500
Maintenance and Labor	$7,200	$7,200
Total O&M Cost	**$61,500**	**$22,700**
20-Year Life Cycle Cost		
20-Year Operating Cost	$1,230,000	$454,000
Total Project Cost	-	$2,249,000
Total 20-Year Present Worth	**$1,230,000**	**$2,703,000**

Table 7.4 20-Year Life Cycle Cost Analysis Influent Pump Station Odor Control Scenario 3 - Inlet H_2S 20 ppm

Item	Phoenix Scrubber	Biological Scrubber
Project Capital Costs		
New Biological Scrubber	-	$780,000
Installation cost (50% of equipment cost)	-	$390,000
Total Direct Cost	**-**	**$1,170,000**
Total Project Cost	**-**	**$2,249,000**
Annual O&M Costs		
Energy	$9,800	$4,000
Media Replacement	$60,000	$7,000
Water	$6,500	$5,500
Maintenance and Labor	$7,200	$7,200
Total O&M Cost	**$83,500**	**$23,700**
20-Year Life Cycle Cost		
20-Year Operating Cost	$1,670,000	$474,000
Total Project Cost	-	$2,249,000
Total 20-Year Present Worth	**$1,670,000**	**$2,723,000**

Table 7.5 20-Year Life Cycle Cost Analysis Influent Pump Station Odor Control Scenario 4 - Inlet H_2S 30 ppm

Item	Phoenix Scrubber	Biological Scrubber
Project Capital Costs		
New Biological Scrubber	-	$780,000
Installation cost (50% of equipment cost)	-	$390,000
Total Direct Cost	**-**	**$1,170,000**
Total Project Cost	**-**	**$2,249,000**
Annual O&M Costs		
Energy	$9,800	$4,000
Media Replacement	$80,000	$7,000
Water	$7,500	$6,500
Maintenance and Labor	$7,200	$7,200
Total O&M Cost	**$104,500**	**$24,700**
20-Year Life Cycle Cost		
20-Year Operating Cost	$2,090,000	$494,000
Total Project Cost	-	$2,249,000
Total 20-Year Present Worth	**$2,090,000**	**$2,743,000**

7.4.2 Headworks Odor Control Cost Analysis

As discussed in Section 7.3.2, a biological scrubber could be used in place of the existing chemical scrubber to treat foul air from the headworks and primary clarifiers. Table 7.6 presents the 20-year life cycle present worth analysis for the headworks odor control. The cost assumes a fan replacement in the capital cost for the chemical scrubbers. Even with this cost addition, the life-cycle cost associated with continued use of chemical scrubbers is significantly lower.

Table 7.6 Headworks Odor Control 20-Year Life Cycle Cost Analysis

Item	Chemical Scrubber	Biological Scrubber
Project Capital Costs		
Chemical Scrubber Fan	$100,000	-
New Biological Scrubber	-	$1,700,000
Installation cost (50% of equipment cost)	$50,000	$850,000
Total Direct Cost	**$150,000**	**$2,550,000**
Total Project Cost	**$288,000**	**$4,901,000**
Annual O&M Costs		
Energy	$37,000	$24,000
Media Replacement	$26,000	$26,000
Chemical Cost	$100,000	-
Water	$8,500	$7,500
Labor	$10,800	$7,200
Total O&M Cost	**$182,300**	**$64,700**
20-Year Life Cycle Cost		
20-Year Operating Cost	$3,646,000	$1,294,000
Total Project Cost	$288,000	$4,901,000
Total 20-Year Present Worth	**$3,934,000**	**$6,195,000**

7.5 Summary and Conclusions

This section presents the summary and conclusions of the odor control evaluation for the influent pump station and headworks facilities at the Rock Creek WRRF.

7.5.1 Influent Pump Station

Continued use of the existing Phoenix carbon system is the most suitable alternative for IPS odor control. This is due to the low concentrations of H_2S, typically less than 5 ppm, measured in the IPS system inlet, but the result does not change if H_2S concentrations are higher, up to 20 ppm.

7.5.2 Headworks

The evaluation shows that continued use of the existing chemical scrubber system is the most economical alternative to treat foul air from the headworks and primary clarifiers.